A 36: Poster – Ultra-cold Atoms, Ions and BEC (joint session A/Q)

Time: Thursday 17:00–19:00 Location: Philo 1. OG

A 36.1 Thu 17:00 Philo 1. OG

Suppressing crosstalk for Rydberg quantum gates — •Gina Warttmann[1], Florian Meinert[2], Hans Peter Büchler[1], and Sebastian Weber[1] — [1]Institute for Theoretical Physics III and Center for Integrated Quantum Science and Technology, University of Stuttgart, 70550 Stuttgart, Germany — [2]5th Institute for Physics and Center for Integrated Quantum Science and Technology, University of Stuttgart, 70550 Stuttgart, Germany

We present a method to suppress crosstalk from implementing controlled-Z gates via local addressing in neutral atom quantum computers. In these systems, a fraction of the laser light that is applied locally to implement gates typically leaks to other atoms. We analyze the resulting crosstalk in a setup of two gate atoms and one neighboring third atom. We then perturbatively derive a spin-echo-inspired gate protocol that suppresses the leading order of the amplitude error, which dominates the crosstalk. Numerical simulations demonstrate that our gate protocol improves the fidelity by two orders of magnitude across a broad range of experimentally relevant parameters. To further reduce the infidelity, we develop a circuit to cancel remaining phase errors. Our results pave the way for using local addressing for high-fidelity quantum gates on Rydberg-based quantum computers.

A 36.2 Thu 17:00 Philo 1. OG

Two-component lattice fermions in an optical cavity: competition between pairing orders — •Loïc Philoxene[1], Michele Pini[2], Francesco Piazza[2], and Walter Hofstetter[1] — [1]Goethe-Universität, Institut für Theoretische Physik, 60438 Frankfurt am Main, Germany — [2]Theoretical Physics III, Center for Electronic Correlations and Magnetism, Institute of Physics, University of Augsburg, 86135 Augsburg, Germany

Ultracold atoms dispersively coupled to an optical cavity experience effective long range interactions, leading to a variety of symmetry breaking patterns. On the other hand, spin-1/2 lattice fermions can locally interact via the Hubbard interaction which, when attractive, generally favors pairing. By considering an ultracold gas of two-component fermionic atoms in a static optical square lattice and dispersively coupled to a ring cavity, we analyze the effects of the competition between the cavity-mediated long range interaction and the Hubbard coupling on the pairing instabilities of the Fermi surface. Using a general Hartree-Fock-Bogoliubov mean-field decoupling of the extended Hubbard Hamiltonian describing the low energy physics of the system, we focus on the competition between the Cooper pairing channel and a specific instance of pair density waves that have been shown to be exactly degenerate with the former in a recent study of a similar system with spinless fermions without an underlying lattice. In particular, we show that the Hubbard interaction lifts this degeneracy, and analyze the competition between both types of pairing order.

A 36.3 Thu 17:00 Philo 1. OG

Optical dipole trapping of mercury — •Sascha Heider, Thorsten Groh, and Simon Stellmer — Universität Bonn, Germany

Mercury, being one of the heaviest laser-coolable elements, is an ideal platform for searches for physics beyond the Standard Model, such as atomic electric dipole moments (EDMs).
We report on the efficient transfer of mercury atoms from a MOT into a high-power (300 W), crossed-beam optical dipole trap paving the way towards degenerate quantum gases of mercury and next-generation atomic EDM searches.

A 36.4 Thu 17:00 Philo 1. OG

QRydDemo - Architecture for Dynamic Tweezer Arrays — •Ralf Berner[1,2], Christopher Bounds[1,2], Manuel Morgado[1,2], Govind Unnikrishnan[1,2], Achim Scholz[1,2], Jiachen Zhao[1,2], Julia Hickl[1,2], Maximilian Kob[1,2], Sebastian Weber[3,2], Hans-Peter Büchler[3,2], Simone Montangero[4], Christoph Tresp[5], Jürgen Stuhler[5], Tilman Pfau[1,2], and Florian Meinert[1,2] — [1]5th Inst. of Physics, University of Stuttgart — [2]IQST — [3]Inst. for Theoretical Physics III, University of Stuttgart — [4]Inst. for Complex Quantum Systems, University of Ulm — [5]TOPTICA Photonics AG

Within the QRydDemo project, we aim to realize a neutral Rydberg atom quantum computer exploiting the Fine-Structure (FS) qubit in ^{88}Sr atoms trapped in optical tweezers. To this end, we demonstrate a novel type of dynamic tweezer architecture consisting of 20 Acusto-Optical Deflectors (AODs) operating at 592 nm, which are individually driven by up to 64 independent Radio-Frequency (RF) tones, enabling array sizes of up to 500 qubits.
This platform, together with fast image analysis and independent real-time RF-control of the AODs, provides the capability of parallel line sorting with an unprecedented dynamical connectivity, which we can utilize for fast sorting and mid-circuit rearrangement of individual atoms at timescales within the coherence time of the qubits.
We present our work on achieving single atom loading and cooling with a scheme that sequentially addresses red sidebands of the narrow intercombination line in strontium via a frequency chirp. This paves the way towards the generation of large, defect-free arrays of qubits.

A 36.5 Thu 17:00 Philo 1. OG

Stroboscopic Quantum Sensing in Trapped-Ion Systems — •Frederike Doerr, Florian Hasse, Tobias Spanke, Ulrich Warring, and Tobias Schaetz — Institute of Physics, University of Freiburg, Hermann-Herder-Straße 3, D-79104 Freiburg, Germany

Trapped ions offer exceptional control over quantum motion, enabling precision studies of dynamical and topological phenomena. We present a stroboscopic measurement technique that provides minimally invasive, time-resolved access to an ion's motional state by maintaining coherence among four coupled oscillators: a global microwave reference, a polarization-gradient travelling-wave light field, and the ion's spin and motional states. The method reaches position and momentum sensitivities at the nanometer and zeptonewton-microsecond scale with sub-100 ns time resolution [1], and recent improvements extend its applicability to non-classical motional states. These capabilities open new opportunities for engineered quantum dynamics, including motional N00N states, spin-motion entanglement transfer, and tests of topological amplification effects in parametrically driven, dissipative ion systems [2]. Moreover, resolving extremely small momentum transfers enables probing the weak energy exchange in atom-ion glancing collisions, essential for validating universal quantum-scattering models underpinning quantum-based pressure standards [3]. This framework thus links coherent motional sensing, topological quantum effects, and single-collision physics within a unified trapped-ion platform. [1] RPA 109, 053105 (2024) [2] arXiv:2502.06960 [3] 2020 Metrologia 57 025015

A 36.6 Thu 17:00 Philo 1. OG

Towards the production of groundstate RbYb — •Arne Kallweit, Céline Castor, and Axel Görlitz — Institut für Experimentalphysik, Heinrich-Heine-Universität Düsseldorf

Ultracold dipolar molecules constitute a promising system for the investigation of topics like ultracold chemistry, novel interactions in quantum gases, precision measurements and quantum information.

Here we report on first experiments in our apparatus for the production of ultracold RbYb molecules. This setup constitutes an improvement of our old apparatus, where the interactions in RbYb and possible routes to molecule production have already been studied extensively [1,2]. In the new setup a major goal is the efficient production of ground state RbYb molecules.

We employ optical tweezers to transport individually cooled samples of Rb and Yb from their separate production chambers to a dedicated science chamber. Here we start to study interspecies interactions of different isotopes by overlapping crossed optical dipole traps. To explore the pathways towards ground state molecules we start with photoassociation spectroscopy near the intercombination line of Yb.

[1] M. Borkowski et al., PRA 88, 052708 (2013)
[2] C. Bruni et al., PRA 94, 022503 (2016)

A 36.7 Thu 17:00 Philo 1. OG

Studying Rydberg-atom-ion interactions with a high-resolution ion microscope — •Maximilian Futterknecht[1], Jennifer Krauter[1], Óscar Andrey Herrera-Sancho[1], Florian Anschütz[1], Utzuri Högl Vidal[1], Moritz Berngruber[2], Florian Meinert[1], Robert Löw[1], and Tilman Pfau[1] — [1]5th Institute of Physics, University of Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart — [2]Max Planck Institute of Quantum Optics, Hans-Kopfermann-Str. 1, 85748 Garching

Our high-resolution ion microscope enables the spatio-temporally resolved study of interactions between Rydberg atoms and ions in a bulk gas of ultra-cold Rubidium atoms. The apparatus has an achievable lateral resolution of at least 200 nm and allows for three-dimensional imaging. In previous years, the setup was used to study the formation and dynamics of a molecular bond between a single ion and a Rydberg atom, as well as the dynamics of unbound atom-ion states. We plan to extend this endeavor by introducing a second Rydberg state. In an unbound configuration, interactions between two Rydberg states tuned by Förster resonances should be experimentally studied. In a next step, we want to create Rydberg-Rydberg-ion bound states by independently exciting two Rydberg states around a central ion. By state-selective extraction of the three constituents of the formed trimers, we plan to tackle the challenge of distinguishing the three particles on our ion detector and detect triple-coincidences. Spectroscopic measurements and high-resolution imaging will be used to extract information on the electronic and spatial structure of the three-body system.

A 36.8 Thu 17:00 Philo 1. OG

Stabilizing binary Bose droplets by ions — •Shunsuke Nishimura, Panagiotis Giannakeas, and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Ultra-dilute liquid droplets formed in binary Bose mixtures constitute weakly interacting yet self-bound quantum fluids, whose quantum-fluctuation-induced stability continues to attract considerable interest. Impurities offer a versatile probe of these systems, and ionic impurities in particular can induce pronounced structural changes through their long-range interactions, as seen in helium nanodroplets. However, their effects in ultra-dilute environments, such as Bose droplets, remain greatly unexplored.

Here we investigate a three-dimensional, spherically symmetric droplet formed by a two-component Bose mixture with contact interactions in the presence of a single ionic impurity. The attractive ion-atom interaction significantly deforms the ground-state density profile and induces a distinct low-lying breathing mode, which remains stable against self-evaporation over a substantially wider range of particle numbers in contrast to the case of the impurity-free droplets. This suggests that ionic impurities offer the possibility to investigate polarons without altering the droplet state even during elementary excitations.

A 36.9 Thu 17:00 Philo 1. OG

Entanglement-enhanced interferometry using single-atom-resolved Twin-Fock states in 87Rb BECs — •Dominik Köster, Martin Quensen, Mareike Hetzel, and Carsten Klempt — Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) Hannover

Atom interferometers are among the most sensitive tools in quantum metrology but are typically limited by the standard quantum limit (SQL). Entangled input states can surpass this bound and approach Heisenberg scaling. We present a metrology-ready 87Rb platform that combines sub-500 ms Bose-Einstein condensate (BEC) production in time-averaged optical potentials with state-resolved, single-atom-resolved detection. We create high-fidelity Twin-Fock states via spin-changing collisions and observe Hong-Ou-Mandel-type atomic interference of up to 10 atoms. Using these states' near-perfect number correlations for heralding, interferometry can be perfomed with large Dicke states for sub-SQL metrology at total atom numbers of 1000 and beyond.

A 36.10 Thu 17:00 Philo 1. OG

MEMS-Mirror-driven Optical Tweezer for Neutral-Atom Quantum Computing. — •Marcel Keck[1], Jonas Witzenrath[1], Tobias Pätkau[1], Jonas Gutsche[1], Dieter Jaksch[2], Niclas Luick[2], Henning Moritz[2], Thomas Niederprüm[1], Herwig Ott[1], Peter Schmelcher[2], Klaus Sengstock[2], Artur Widera[1], Shanshan Gu-Stoppel[3], Paul Raschdorf[3], and Lena Wysocki[3] — [1]RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [2]University of Hamburg, 22761 Hamburg, Germany — [3]Fraunhofer Institute for Silicon Technology, 25524 Itzehoe, Germany

Neutral-atom-based quantum computers are a promising platform for addressing complex optimization problems. These require the ability to deterministically move atoms, not only for initializing a qubit array but also for reaching an all-to-all connectivity. Within the Rymax One project, we investigate mirrors based on Micro-Electro-Mechanical Systems (MEMS) technology to create movable optical tweezers. The development of a new piezo-electric material by the Fraunhofer ISIT that exhibits minimal hysteresis enables the precise positioning of a small mirror surface. In contrast to conventional methods (e.g., AODs), these mirrors introduce no position dependent frequency shift, allow atom movement in all three spatial dimensions, and have a high reflectivity across a broad range of frequencies, including the ultraviolet. To address the entire atomic array of the Rymax One quantum processor, we simulate an optical setup. We characterize different MEMS mirror models and find optimal parameters to ensure quick and stable movement. The oscillations that occur are eliminated.

A 36.11 Thu 17:00 Philo 1. OG

An Atomtronic Toolbox for Josephson Physics — •Florian Binoth, Kaih T. Mitchell, Erik Bernhart, Jan Gerhardt, Marvin Röhrle, and Herwig Ott — Department of Physics and Research Center OPTIMAS, Rheinland-Pfälzische Technische Universität Kaiserslautern-Landau, 67663 Kaiserslautern, Germany

We present an atomtronic toolbox to study quantum transport phenomena and quantum scattering problems using Bose-Einstein condensates (BECs) in spatially and temporally modulated optical potential landscapes. Our platform generates arbitrary optical potentials with a multi-axis acousto-optical deflector and a digital micromirror device. Additionally, we are developing the implementation of a novel sub-wavelength dark-state barrier using a pair of resonant Raman beams, with differing transverse modes, projected onto the atoms through an in-vacuum objective lens. The atoms are imaged using a multi-directional absorption imaging system and a scanning electron microscope with high spatial resolution.

This apparatus allows us to investigate atomtronic superconducting Josephson junctions, constructed by introducing a tunnelling barrier into a tube-shaped BEC. With an appropriate combination of AC and DC driving, the current-voltage curve of the device shows discrete Shapiro steps, that have previously been demonstrated in solid-state superconductors and form the Josephson voltage standard. We investigate the microscopic origins of this behaviour and demonstrate that in our quantum gas platform they directly connected to phonon emission and vortex dynamics.

A 36.12 Thu 17:00 Philo 1. OG

Fano-suppression of losses in scattering resonances of bosonic erbium — •Arfor Houwman[1], Louis Lafforgue[2], Sarah Embacher[1], Manfred Mark[1,2], and Francesca Ferlaino[1,2] — [1]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften — [2]Universität Innsbruck, Institut für Experimentalphysik, 6020 Innsbruck, Austria

Lanthanides exhibit remarkable complexity in their scattering properties due to their numerous valence electrons which is reflected in the exceptionally dense Feshbach spectrum in the ground state. Here we explore the situation of bosonic spin mixtures of erbium, adding the additional spin degree to the problem. We observe inter- and intra-spin scattering resonances exhibiting a peculiar Fano shape with a pronounced loss minimum, indicating a destructive interference phenomenon. Our multi-channel model captures the essential behaviour and additionally predicts a series of Fano-Feshbach resonances across multiple spin compositions connected to the same molecular state. We observe this series and find good agreement to our model. Our work opens the door for a detailed investigation to study multi-spin strongly-coupled scattering phenomena.

A 36.13 Thu 17:00 Philo 1. OG

A Cryogenic Surface Trap for experiments with Rydberg ions — •Vinay Shankar[1], Marion Mallweger[1], Simon Schey[1,2], Natalia Kuk[1], Ivo Straka[1], Robin Thomm[1], and Markus Hennrich[1] — [1]Department of Physics, Stockholm University, Stockholm, Sweden — [2]Infineon Technologies Austria AG, Villach, Austria

Trapped Rydberg ions are a unique platform for quantum information processing, metrology and simulations [1,2] as they combine the exceptional control over trapped ions with the tunable, long-range interactions of Rydberg states. Rydberg ions have been used to demonstrate sub-microsecond entangling gates [3]. One of the biggest challenges while working with Rydberg ions is double ionisation due to blackbody radiation, since Rydberg states are close to the ionisation threshold. The operation of the system in a cryogenic environment would reduce this effect significantly, and here we present such an experimental system. The setup hosts a surface ion trap, with separate trapping and experimental zones. Here we present the first measurements with the surface trap with the goal of showcasing Rydberg excitations on such a system. The large polarisability of Rydberg ions makes them highly sensitive to surrounding electric fields and can be utilised as a precise probe for sensing electric fields around the chip.

[1] M. Müller, et al., NJP, 10, 093009 (2008).
[2] F. Schmidt-Kaler, et al., NJP, 13, 075014 (2011).
[3] C. Zhang, et. al., Nature 580, 345 (2020)

A 36.14 Thu 17:00 Philo 1. OG

Fast single atom spin and number resolved imaging of SU(N) fermions — •Leon Schäfer[1,2], Sophie Häfele[1,2], Thies Plassmann[1,2], Meny Menashes[1,2], and Guillaume Salomon[1,2] — [1]Institute for Quantum Physics, Hamburg University, Luruper Chaussee 149, 22761 Hamburg — [2]The Hamburg Center for Ultrafast Imaging, Hamburg University, Luruper Chaussee 149, 22761 Hamburg

Large local Hilbert spaces are of key interest in quantum science with applications in quantum-computing, -memories, and -simulation of strongly-correlated systems. Multilevel quantum systems such as superconducting circuits, trapped ions, cold molecules and ultracold atoms offer the possibility to realize qudits. Yet, the simultaneous control and detection of multiple quantum states at the single-particle and state level remain a significant challenge. State-of-the-art quantum simulators with single particle and spin detection, such as quantum gas microscopes, also suffer from limited state selectivity and long detection times. We present a rapid imaging technique enabling the simultaneous detection of up to four quantum states encoded in the nuclear spin manifold of ^{87}Sr within $100\,\mu s$. By combining an optical Stern-Gerlach separation protocol with high-fidelity ultrafast imaging in free space we achieve state-resolved detection fidelities in the range of 95-99.3%. This method is compatible with the joint detection of multiple atoms initially confined within the same optical trap. Our technique offers fascinating perspectives for quantum science with alkaline-earth atoms ranging from qudit based quantum computing to quantum gas microscopy of the SU(N) Fermi-Hubbard model.

A 36.15 Thu 17:00 Philo 1. OG

Towards Autonomous Optical Alignment for NV-Center and SHG Experiments — •Zhen Mi, Tobias Spanke, Frederike Dörr, Jörn Denter, Ulrich Warring, and Tobias Schätz — Physikalisches Institut, Albert-Ludwigs-Universität, Freiburg

We present an automated beam-alignment framework designed for optical experiments requiring long-term stability, in particular NV-center excitation/collection paths and second-harmonic generation (SHG) stages. Stable and reproducible alignment is essential for maintaining photon rates, SHG efficiency, and experimental reliability, yet manual alignment suffers from drift, operator dependence, and time overhead. Our approach combines motorized mirror mounts, in-loop detectors, and gradient-free optimization routines to autonomously explore multi-parameter alignment spaces. We benchmark the system on NV-center fluorescence collection and SHG cavity coupling. The automated routines consistently improve alignment quality, reduce sensitivity to mechanical and thermal drifts, and increase reproducibility across repeated optimization cycles. We further analyze critical aspects such as distinguishing signal drift from noise, managing low-SNR conditions, and maintaining robustness over long measurement sequences. These results lay the groundwork for self-calibrating optical experiments and scalable, low- maintenance optical setups for quantum sensing and nonlinear optics.

A 36.16 Thu 17:00 Philo 1. OG

Effects of of two-body interactions and quenched disorder on the spectrum and topology of the time-periodically driven Haldane-Falicov-Kimball model — •Souradeep Roy Choudhury[1], Arijit Dutta[1], Tao Qin[2], and Walter Hofstetter[1] — [1]Goethe-Universität, Institut für Theoretische Physik, 60438 Frankfurt am Main, Germany — [2]School of Physics, Anhui University, Hefei, Anhui Province 230601, People's Republic of China

We investigate the time-periodically driven disordered Haldane-Falicov-Kimball model on a honeycomb lattice using real space Floquet dynamical mean field theory. For the clean, noninteracting system, the time-periodic nonequilibrium steady state (NESS) resembles an equilibrium Haldane phase at large driving frequencies but has no effective equilibrium description at intermediate driving frequencies. In presence of the Falicov-Kimball interaction, the pumped charge in a cylinder geometry with a threaded flux does not remain quantized, due to the broadening of the spectral edge modes with increasing interactions till the Mott transition. The rate of energy dissipation into the bath for the clean system shows remarkably different behaviour between the intermediate and large frequency driving regimes. Upon adding onsite static disorder to this system, we find disorder-induced spectral broadening.

A 36.17 Thu 17:00 Philo 1. OG

Transportable magneto-optical trap of strontium for educational outreach — •Darius Hoyer, Sophia Paul, Johanna Kramer, and Simon Stellmer — Physikalisches Institut, Bonn, Deutschland

The broad linewidth of the 461 nm transition of strontium enables efficient laser cooling and trapping, producing a bright MOT visible to the naked eye. This makes the Sr MOT an ideal, accessible system for demonstrating physics and quantum optics.
We present both the simulation and realization of a portable Sr MOT using permanent magnets for the Zeeman slower and the MOT.

A 36.18 Thu 17:00 Philo 1. OG

Design of a Dual-Species Atomic Beam Source for High Rubidium and Lithium Flux — •Florian Anschütz[1], Raphael Benz[1], Jennifer Krauter[1], Maximilian Futterknecht[1], Utzuri Ursula Högl Vidal[1], Óscar Andrey Herrera Sancho[1,2], Florian Meinert[1], Robert Löw[1], and Tilman Pfau[1] — [1]5. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — [2]Escuela de Física, Universidad de Costa Rica, 2060 San Pedro, San José, Costa Rica

Lithium is a promising atomic platform for studying Rydberg molecules in the ultracold regime. For example Rydberg molecules made from Li atoms will allow for resolved rotational spectra, and will allow to study atom ion collisions in the quantum regime. We present the design of a rubidium-lithium dual-species atomic beam source developed for future integration into a high-resolution ion microscope. In order to advance towards dual-species scattering experiments with rubidium and lithium, a bright and well-controlled dual-species atomic beam source is essential. The current source produces overlapping Rb and Li beams with estimated MOT loading rates on the order of 1×10^9 1/s for ^{87}Rb (120 °C) and 3×10^9 1/s for ^{6}Li (400 °C) under dual-species operation. With an improved design, we aim to increase the Rb flux by a factor of $2-3$ while maintaining comparable single-species flux performance. We backup this new design with Monte-Carlo Molecular-Dynamics simulations.

A 36.19 Thu 17:00 Philo 1. OG

Characterizing Radio Frequency-Induced Pressure Variations in Glass-Cell Vacuum Systems — •Vicente Baca, Alexander Guthmann, Louisa Kienesberger, Felix Lang, David Gopalan, Eleonora Lippi, and Artur Widera — RPTU Kaiserslautern-Landau

In recent years, radio-frequency (RF) magnetic fields have become increasingly important tools in ultracold-atom and quantum-gas experiments. Because many of these experiments rely on glass-cell vacuum chambers, where stable ultra-high vacuum (UHV) is critical, it is essential to verify that the presence of an RF coil (or any source of time-dependent magnetic fields) does not compromise vacuum integrity. In the present work a tunable RF coil was placed near a quartz glass-cell and driven over the MHz regime while monitoring the chamber pressure in real time. We observe frequency dependent pressure variations correlated with the magnitude of the applied RF field. The results contribute to understanding RF-induced perturbations in UHV environments and enhance the design of vacuum systems that incorporate RF fields.

A 36.20 Thu 17:00 Philo 1. OG

Investigating structural phase transitions in dipolar quantum gases — Christian Gölzhäuser, •Lily Platt, Karthik Chandrashekara, Jianshun Gao, Manon Ballu, Wyatt Kirkby, and Lauriane Chomaz — Physikalisches Institut, Universität Heidelberg, Germany

Dipolar quantum gases have allowed the discovery of novel many-body states (e.g. supersolids), while at the same time providing an outstanding degree of control and tunability. In our new-generation experiment at Heidelberg we aim to study the behaviour of dipolar quantum gases of dysprosium in low dimensions and uniform tailored potentials. Here we report on our investigations on structural phase transitions both from a uniform to a density modulated state by tuning the s-wave scattering length and between a triangular crystal lattice modulation and a stripe-like modulation. We are able to observe the stripe modulation by tilting the orientation of our dipoles in plane through an external field. In both cases of the modulation we are able to observe phase coherence in a small range of scattering lengths below the superfluid to supersolid transition. We aim to study the nature of the different transitions to and within the density modulated regime.

A 36.21 Thu 17:00 Philo 1. OG

Microwave-Optical Multiphoton Lattice for an Ultracold Atomic Rubidium Quantum Gas — •Patrick Haas, Stefanie Moll, and Martin Weitz — Institut für Angewandte Physik, Bonn, Germany

Quantum simulations of solid state physics theory effects, as well as many applications in quantum information, strongly benefit from recent advances obtained with cold atoms in optical lattices. Here we report on progress in the development of a state-selective optical lattice for alkali atoms despite the usage of extremely far detuned trapping light fields. For this, we employ a doubly resonant lattice scheme that combines optical and microwave transitions. We present both the basic working scheme as well as results of a proof-of-principle experiment demonstrating the resulting spatially varying trapping potential for cold rubidium atoms. Prospects of this work include fault-tolerant quantum computation as well as measurement-based quantum information processing.

A 36.22 Thu 17:00 Philo 1. OG

Towards continuous superradiance in Strontium-88 — •Ying Cui, Luuk Michels, Elisa Wenzel, Benedikt Heizenreder, Ananya Sitaram, and Florian Schreck — University of Amsterdam

Superradiance is a collective light-matter phenomenon with the potential of significantly enhancing the short-term stability of optical clocks. While pulsed superradiance has already been demonstrated, we envision a steady supply of ultracold atoms actively transported through the lasing region to achieve continuous operation. Here we present two sub-projects towards continuous superradiance on the millihertz line of Strontium-88. We plan to employ a bow-tie cavity to form a moving optical lattice that acts as a conveyor belt for transporting atoms from a reservoir into the emission region. The first objective is to couple and lock the cavity to this lattice light and to implement a probing setup that targets the 689 nm 1S0-3P1 transition in Strontium. A further key requirement is the controlled, yet incoherent preparation of atoms in the upper lasing state, preventing any imposed phase relation between the pump beams and the emitted superradiant field. To this end, we aim to develop and implement a multi-level pumping scheme, supported by a frequency and intensity stabilized repumping system integrated into the experiment.

A 36.23 Thu 17:00 Philo 1. OG

Tools for quantum simulation with circular Rydberg states of a divalent atom — •Aaron Götzelmann, Einius Pultinevicius, Armin Humic, Marius Thomas, Christian Hölzl, Fabian Thielemann, and Florian Meinert — 5. Physikalisches Institut, Universität Stuttgart, Stuttgart, Germany

In our quantum experiment we aim to realize a quantum simulator with circular Rydberg states (CRS) of strontium. Compared to low-ℓ Rydberg states, CRS offer orders-of-magnitude longer lifetime, which allows for overcoming fundamental limitations for system coherence. The maximally allowed angular momentum and magnetic quantum numbers provided by the CRS yield limited decay channels, that can be suppressed by decreasing the mode-density in the black-body regime leading to extreme lifetimes [1]. To this end we use the Purcell-effect provided by a capacitor structure around the atoms [2].

As a divalent alkaline-earth Rydberg atom, strontium offers several advantages over monovalent elements because of the optically active ionic core. This is specifically true for CRS, which allows for coherent operation of the Sr^+ ion with its level structure. This gives rise to various tools for our quantum simulator, such as trapping, cooling, side selective addressing [3], and fluorescence imaging of Rydberg atoms. In my contribution, I will show our endeavours on the optical detection of a CRS.

[1] Pultinevicius et al., arXiv:2510.27471 (2025)
[2] Hölzl et al., Phys. Rev. X 14, 021024 (2024)
[3] Wirth et al., Phys. Rev. Lett. 133, 123403 (2024)

A 36.24 Thu 17:00 Philo 1. OG

Fast SLM holography for arbitrary atom transport in neutral atom QPUs. — •Maximilian Kob[1,2], Christopher Bounds[1,2], Manuel Morgado[1,2], Govind Unnikrishnan[1,2], Ralf Berner[1,2], Achim Scholz[1,2], Jiachen Zhao[1,2], Julia Hickl[1,2], Tilman Pfau[1,2], and Florian Meinert[1,2] — [1]5th Inst. of Physics, University of Stuttgart — [2]IQST

We report on progress towards a fully dynamical optical tweezer platform employing fast, phase-only spatial light modulators (SLMs) within the QRydDemo demonstrator. Due to intensity flickering along sequences of Gerchberg-Saxton (GS)-based holograms, smooth transitions between frames are generated using the Linear Phase Interpolation (LPI) method [1]. This mitigates losses during transport through light-field phase control. Our control software has been adapted to include a GPU-accelerated implementation of the LPI and to support arbitrary two-dimensional trajectories. The neutral-atom platform based on optical tweezers offers the possibility of 3-dimensional (3D) atom assembly. We compare several methods for generating static 3D holograms and evaluate their suitability for atom transport, supported by optical and dynamical simulations. To enable fully 3D atom transport for sorting and shuttling, we further present an evaluation of the performance of different techniques for generating 3D holograms near kHz timescales.

[1] I. H. A. Knottnerus et. al. SciPost Phys. 19, 118 (2025)

A 36.25 Thu 17:00 Philo 1. OG

Design of a new accordion optical lattice for a quantum gas microscope — •Lennart Hoenen[1], Carlos Gas[2], Andreas Meyer[2], Lauriane Chomaz[1], and Leticia Tarruell[2] — [1]Physikalisches Institut Heidelberg, Im Neuenheimer Feld 226, 69120 Heidelberg, Germany — [2]ICFO - The institute of photonic sciences, Mediterranean Technology Park, Avinguda Carl Friedrich Gauss, 3, 08860 Castelldefels, Barcelona, Spain

In this poster, the design of a dynamically tunable accordion optical lattice is presented, which was developed for the Strontium quantum gas microscope experiment in the Tarruell group. The design is expected to enable dynamic tuning of the vertical confinement from 9kHz to 25kHz, corresponding to a change in lattice spacing from 1.9um to 5.1um, while remaining below 80Hz in the horizontal direction. The functionality of the accordion lattice is demonstrated in a dedicated test setup, validating its performance and tunability.

This technical advancement opens new possibilities for exploring strongly correlated SU(N) symmetric systems in tailored 2D geometries under a quantum gas microscope

A 36.26 Thu 17:00 Philo 1. OG

Morphological false vacuum decay in dipolar supersolids — •Wyatt Kirkby[1,2], Thomas Gasenzer[2], and Lauriane Chomaz[1] — [1]Physikalisches Institut, Universität Heidelberg, Heidelberg, Germany — [2]Kirchhoff-Institut für Physik, Universität Heidelberg, Heidelberg, Germany

We theoretically study false vacuum decay between two morphologically distinct phases of a two-dimensional atomic dipolar supersolid via bubble nucleation, within an extended Gross-Pitaevskii framework including quantum fluctuations. We model the decay rate by deriving an effective action and instanton bounce solution describing the transition between honeycomb and stripe supersolid orders. Numerical simuations of stochastic decay events are then compared against this field-theoretic approach. We also compare bubble growth velocities with the longitudinal and transverse sound speeds of the competing supersolid orders.

A 36.27 Thu 17:00 Philo 1. OG

Rymax one: A neutral atom quantum processor to solve optimization problems — •Silvia Ferrante[1], Jonas Witzenrath[2], Tobias Ebert[1], Kapil Goswami[1], Hendrik Koser[1], Tobias Pätkau[2], Benjamin Abeln[1], Hauke Biss[1], Giovanni de Vecchi[1], Jonas Gutsche[2], Nader Mostaan[1], Rick Mukherjee[3], Suthep Pomjaksilp[1], Niclas Luick[1], Thomas Niederprüm[2], Dieter Jaksch[1], Henning Moritz[1], Herwig Ott[2], Peter Schmelcher[1], Klaus Sengstock[1], and Artur Widera[2] — [1]University of Hamburg, 22761 Hamburg, Germany — [2]RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [3]University of Tennessee, TN 37996 Knoxville, USA

From the optimisation of supply chains to efficient vehicle routing - computationally hard problems are deeply embedded into modern society. Finding solutions to these problems via classical means still requires substantial computational effort. Quantum processors, on the contrary, promise a significant advantage in solving them.

Here we present Rymax one, a quantum processor based on neutral

Ytterbium designed to explore the potential of quantum computing for real world applications. The level structure of Yb naturally provides qubits with long coherence times as well as high-fidelity gate operations. These features allow us to realise a scalable platform to test the performance of novel quantum algorithms tailored to tackle real-world problems.

A 36.28 Thu 17:00 Philo 1. OG

Stabilizing the repulsive Bose polaron — •René Henke, Cesar R. Cabrera, and Henning Moritz — Institut für Quantenphysik, Universität Hamburg

Mobile impurities interacting with a quantum medium form quasiparticles known as polarons, a central concept in many-body physics. While the quantum impurity problem has been extensively studied with ultracold atomic gases, repulsive polarons in the strongly correlated regime have remained elusive. Typically, impurity atoms bind to molecules or rapidly decay into deeper-lying states before they can acquire an appreciable dressing cloud. Here, we report on the realization of polarons in a strongly repulsive quasi-two-dimensional quantum gas. Using a superfluid of ^{6}Li dimers, we introduce impurities by promoting a small fraction of the dimers into higher levels of the transverse confining potential. These synthetic-spin polarons give access to the strongly repulsive regime where common decay channels are suppressed. We extract key polaron properties—the energy, quasiparticle residue, and effective mass—using trap modulation and Bragg spectroscopy. Our measurements are well captured by a microscopic T-matrix approach and quantum Monte Carlo simulations, revealing deviations from mean-field predictions. In particular, we measure a significant enhancement of the polaron mass, with values exceeding twice the free dimer mass. Our demonstration of a stable repulsive Bose polaron establishes a platform for studying impurity physics in low-dimensional and strongly correlated systems.

A 36.29 Thu 17:00 Philo 1. OG

Temperature-dependent extended Gross-Pitaevskii treatment for dipolar quantum gases — •Julian Kusch, Wyatt Kirkby, and Lauriane Chomaz — Physikalisches Institut, Universität Heidelberg

We investigate the theoretical effects of finite temperature on dipolar quantum gases. The extended Gross-Pitaevskii equation (eGPE) serves as the general framework, including isotropic contact interactions, anisotropic long-range dipole interactions and beyond-mean-field effects. By extending the eGPE to include a term based on Bogoliubov theory, we describe the influence of finite temperatures and study the impact on the phase diagram and real-time evolution. We also compare our results directly with experimental observations from the Heidelberg Dysprosium lab.

A 36.30 Thu 17:00 Philo 1. OG

Progress toward a Lithium-based quantum gas microscope — •Shaurya Bhave, Ruijia Li, Binayak Rout, and Timon Hilker — University of Strathclyde, Glasgow, United Kingdom

Neutral atoms have taken ground as a compelling platform, for both analog and digital quantum simulation. They bring several advantages such as long lifetimes, naturally identical qubits, and inherent scalability. Optical lattice based tunneling gates, are expected to enhance the toolkit of simulation experiments to realise hybrid quantum processors. This approach combines the power of Hubbard simulations, with the programmability of quantum gates, utilising the inherent fermion exchange statistics of cold atoms. Here we present our progress towards a new lithium quantum gas microscope. Our goal is to gain full control over the motion of the atoms, by employing an optical superlattice and single site addressing to create quantum gates. We aim for fast cycle times and robust preparation of deeply degenerate gases using a single-chamber design with a high-power optical lattice directly loaded from a MOT.

A 36.31 Thu 17:00 Philo 1. OG

Long-lived giant circular Rydberg states at room temperature for quantum simulation — •Einius Pultinevicius, Aaron Götzelmann, Armin Humic, Marius Thomas, Fabian Thielemann, Christian Hölzl, and Florian Meinert — 5. Physikalisches Institut, Universität Stuttgart

Highly excited Rydberg atoms feature extreme properties, making them valuable for many applications ranging from sensing to the use in quantum computing and simulation. Commonly used low-ℓ, optically accessible Rydberg states have a limited lifetime which imposes a fundamental restriction on their coherence times. In our experiment, we overcome this limitation by transferring the Rydberg electron to a circular Rydberg state (CRS) with maximally allowed orbital momentum. The use of a transparent capacitor with indium-tin-oxide-coated glass plates reduces the mode-density of resonant black-body photons, further increasing the lifetime while preserving optical access.

Here, we characterize this effect over a wide range of n from 79 up to 101, enabled by successive coherent population transfer between close-by CRS. The measured decay dynamics indicate additional resonant features involving additional decay paths, which are explained by taking into account the full electrode structure around the atom. We demonstrate lifetimes reaching 10 ms at room-temperature and a trapping time of more than 100 ms, paving the way for experiments with Rydberg atoms on unprecedented timescales.

A 36.32 Thu 17:00 Philo 1. OG

Towards Lithium Bose-Fermi-mixtures in a compact experimental apparatus — •Jonathan Bracker, Martin Guillot, and Christof Weitenberg — Technische Universität Dortmund

We present the design of a versatile lithium quantum gas machine with a 2D/3D MOT setup and high-resolution access with an NA of 0.5. A matter-wave microscope using optical traps allows magnifying the density by a factor of 35. It also enables the realisation of a phase microscope, mapping phase fluctuations to density fluctuations for a BEC in a triangular optical lattice. Upon the reassembly of the machine after relocation, we are currently implementing an upgrade to allow for the preparation of Bose-Fermi mixtures of Li7 and Li6. We present the laser system that provides all the necessary frequencies for simultaneous sub-Doppler laser cooling as well as future plans to use the mixture for studying various scenarios of driven-dissipative systems. In particular, we will use the Li6 cloud as a bath to absorb heating of a Li7 system upon manipulation with moderately near-resonant light.

A 36.33 Thu 17:00 Philo 1. OG

Optimizing pulsed resolved sideband cooling outside the Lamb–Dicke regime — •Elwin A. Dijck, Sebastian Davidson, Ruben B. Henninger, Shreya Rao Kodancha, Devanarayanan Rajeeb Kumar, Stepan Kokh, Vera M. Schäfer, Thomas Pfeifer, and José R. Crespo-López Urrutia — Max-Planck-Institut für Kernphysik, Heidelberg

Cooling ions to the motional ground state of their harmonic trapping potential minimizes Doppler shifts and enables techniques like quantum logic spectroscopy. Ion motion modulating a narrow transition produces resolved sidebands that allow changing the motional state in controlled steps beyond the Doppler limit. In the Lamb–Dicke regime, the modulation is small: repeated excitation of the first-order red sideband and repumping successively lowers the phonon number to zero.

Limited trap depth may prevent reaching this regime and presents challenges in sideband cooling: the Doppler limit now corresponds to a larger initial phonon number, and absorption and emission during repumping cause significant heating. However, the larger modulation index also produces higher order sidebands in the spectrum, allowing removal of more than one phonon per step.

Simulating the probability distribution over Fock states for one and two-ion crystals during the cooling process, we investigate optimized pulse sequences for different combinations of Lamb–Dicke factors and ion species, considering in particular mixed-species crystals comprising a Be^+ ion and a highly charged ion.

A 36.34 Thu 17:00 Philo 1. OG

Confinement-induced stabilization of a resonantly interacting ultracold Bose-Fermi mixture — •Tommaso Vedovello, D Digvijay, Premjith Thekkeppatt, Klaasjan van Druten, and Florian Schreck — Van der Waals-Zeeman Institute, University of Amsterdam, Netherlands

Alkaline–alkaline-earth dimers exhibit both an electric and a magnetic dipole moment and they are a promising platform for studying quantum many-body effects, precision measurements, quantum computation and quantum chemistry. In our experiment [1] we aim to produce such molecules starting from an ultracold Bose-Fermi 87Rb-87Sr mixture. The ultracold scattering properties of this mixture have been previously determined in our group [2,3], and the mixture was found to be resonantly interacting, with losses attributed to 3-body recombination [4]. We observed the suppression of these losses by confining the gas to lower dimension in a 1D optical lattice . In such a quasi-2D regime, the resonantly interacting mixture has a long lifetime, up to hundreds of milliseconds, which is an excellent starting point for pursuing molecule formation, for instance through confinement-induced resonance [5]. Our immediate next goal is to confirm this through a two-photon scheme (STIRAP). This is the next step towards creating the first ultracold open-shell heteronuclear ground-state molecules.

[1] P. Thekkepatt, et al., PRL 135, 193001 (2025) [2] A. Ciamei, et al., Phys.Chem.Chem.Phys 20, 26221 (2018) [3] V. Barbé et al., Nat. Phys.14, 881 (2018) [4] P.O. Fedichev, et al., PRL 77, 2921 (1996) [5] L. Oghittu et al., PRA 112, 043313 (2025)

A 36.35 Thu 17:00 Philo 1. OG

Bayesian Optimization of Measurement Protocols for the Thermometry of Ultracold Gases — •Luca Leon Granert, Julian Fess, Sabrina Burgardt, Silvia Hiebel, and Artur Widera — Department of Physics, RPTU University Kaiserslautern-Landau, 67663 Kaiserslautern, Germany

Precise thermometry in ultracold gases is essential for exploring quantum many-body phenomena. Established methods, such as time-of-flight thermometry, lose precision in regimes with weak signals and often destroy the sample. Quantum probes provide a non-destructive approach by encoding environmental information into internal states with minimal disturbance to the system. In this work, spin-based quantum thermometers are realized by immersing individual Cs atoms into an ultracold Rb bath. Inelastic spin-exchange processes between probe and bath transfer motional and thermal information onto the internal spin states. The information gained per inelastic event increases when nonequilibrium spin dynamics are exploited. The optimal parameters for this process depend on the temperature being estimated, making this system well-suited for Bayesian estimation strategies. Three measurement protocols are investigated: an unoptimized, an a priori optimized, and an adaptively optimized version. Their performance is evaluated based on their convergence behavior and achievable estimation accuracy. The a priori optimized protocol shows the best performance in this comparison. These results show that nonequilibrium probe dynamics can enhance quantum thermometry, supporting efficient and precise temperature estimation in ultracold environments.

A 36.36 Thu 17:00 Philo 1. OG

Realizing and probing programmable 2D optical lattices with flexible geometries and connectivity — •Sheng-Hung Wang[1,2], Kritsana Srakaew[1,2], David Wei[1,2], Daniel Adler[1,2], Suchita Agrawal[1,2], David Gröters[1,2], Pascal Weckesser[1,2], Immanuel Bloch[1,2,3], and Johannes Zeiher[1,2,3] — [1]Max-Planck-Institut für Quantenoptik, Garching, Germany — [2]Munich Center for Quantum Science and Technology, Munich, Germany — [3]Fakultät für Physik, Ludwig-Maximilians-Universität, Munich, Germany

Optical lattices are a versatile platform for studying complex and highly correlated quantum many-body systems. For most experiments, the layout of the confining lattice beams restricts the accessible lattice geometries and the underlying physics. We recently overcame this challenge by introducing a passively phase-stable tunable lattice, which offers programmable cell connectivity and flexible geometries, including square, triangular, Lieb, and Kagome lattices [1]. In this poster, we present our tunable lattice geometries and demonstrate out-of-equilibrium quantum walks for different settings. Furthermore, we introduce a new upgrade that will enable mid-sequence tunabilty, allowing for doublon and spin-resolved imaging. In addition, we discuss cooling techniques that will boost the overall preparation time for ultracold atoms in optical lattices.

[1] Wei et al. Physical Review X 13.2 (2023): 021042.

A 36.37 Thu 17:00 Philo 1. OG

Spin-resolved microscopy of an SU(N) Fermi-Hubbard system — •Leonardo Bezzo[1], Carlos Gas-Ferrer[1], Sandra Buob[1], Antonio Rubio-Abadal[1], and Leticia Tarruell[1,2] — [1]ICFO, Castelldefels (Barcelona), Spain — [2]ICREA, Barcelona, Spain

Quantum-gas microscopes have provided direct access to the phases of the Fermi-Hubbard model. For SU(2) systems, they have brought microscopic insight into the complex competition between interactions, quantum magnetism, and doping. Alkaline-earth(-like) fermions extend this spin-1/2 paradigm by giving access to SU(N) Fermi-Hubbard models, with rich phase diagrams to be unveiled. Despite its fundamental interest, a microscopic exploration of SU(N) quantum systems has remained elusive. We report the realization of a quantum-gas microscope for fermionic ^{87}Sr. Our fluorescence imaging scheme, based on cooling and detection on the narrow intercombination line at 689 nm, enables spin-resolved single-atom detection. By combining it with an optical pumping protocol, we are able to detect the 10 spin states occupation in a single experimental run, a crucial capability for probing site-resolved magnetic correlations. Moreover, we characterize the fundamental inelastic photon scattering processes that limit the site-resolved fidelity of our imaging protocol, and demonstrate an extension of our method that allows us to reach fidelities > 96% for systems up to SU(8). These results establish ^{87}Sr quantum-gas microscopy as a powerful approach to study exotic magnetism in the SU(N) Fermi-Hubbard model, and provide a new detection tool with potential applications to quantum simulation, computation, and metrology.

A 36.38 Thu 17:00 Philo 1. OG

Enhanced Atom Capture via Multi-Frequency Magneto-Optical Trapping — •Benjamin Hopton, Nathan Cooper, and Lucia Hackermuller — School of Physics and Astronomy, University of Nottingham, UK

Cold atom traps have a wide range of applications, from sensing—in devices such as magnetometers and gravimeters—to tests of fundamental physics. Increasing the size of these atom traps increases the sensitivity of such experiments; additionally, increasing the load rate of these traps inevitably increases the bandwidth of any device using these traps. We deliver an experiment showing that using multi-frequency cooling light in a Rb-87 magneto-optical trap (MOT) doubles the total number of atoms captured (capturing up to 1.3×10^{10} atoms) and further improves the load rate of the trap three-fold (up to $1.2 \times 10^{11}\,\mathrm{s}^{-1}$) compared to a traditional single-frequency MOT using the same apparatus. The use of multiple frequencies, each separated on the order of the natural linewidth of the atomic transition in question, allows a larger range of Doppler shifts—or higher velocity classes—to be available for excitation from the laser; this allows atoms to remain on resonant with the laser as it is cooled, increasing the capture velocity of a MOT for the same given size. We aim to continue optimising the setup for greater increase in both loading rate and steady-state atom number, in addition to implementing high atom number interferometric techniques, of which we have simulated.

A 36.39 Thu 17:00 Philo 1. OG

Towards a UV single-site addressing system for a hybrid fermionic quantum processor — •Ino Ahrens[1,2], Francesco Testi[1,4], Luca Muscarella[1,3], Robin Groth[1,3], Andreas von Haaren[1,3], Liyang Qiu[1,3], Titus Franz[1,3], Philipp Preiss[1,3], and Immanuel Bloch[1,3,4] — [1]Max-Planck Institute of Quantum Optics — [2]Technical University of Munich — [3]Munich Center for Quantum Science and Technology — [4]Ludwig Maximilian University Munich

FermiQP is a demonstrator for a fermionic quantum processor utilizing ultracold fermions in optical lattices. Operating in analog mode, the system facilitates precision studies of the two-dimensional Fermi-Hubbard model. In its digital mode, it aims to implement a universal gate set on the spin degree of freedom, enabling advanced state engineering and local basis transformations. We present a single-atom addressing scheme for coherently manipulating the internal states of individual Lithium-6 atoms in an optical lattice. The scheme employs differential light shifts near a UV transition at 323 nm, maximizing atomic coherence while minimizing cross-talk to neighboring lattice sites. We report on the characterization of our high numerical aperture UV microscope objective and the current status of the implementation of our single-site addressing setup, which incorporates two polarization independent AODs.

A 36.40 Thu 17:00 Philo 1. OG

Photonic bandgaps and normal mode splitting in lattices interacting with optical cavities — Philippe Wilhelm Courteille[1], •Dalila Rivero[1], Gustavo Henrique de França[1], Claudio Alves Pessoa Junior[1], Ana Cipris[1], Mayerlin Nuñez Portela[2], Raul Teixeira[3], and Sebastian Slama[4] — [1]Instituto de Física de São Carlos, Universidade de São Paulo, São Carlos, São Paulo 13566-970, Brazil — [2]Laboratorio de Óptica Cuántica, Universidad de los Andes, A.A. 4976, Bogotá D.C., Colombia — [3]Departamento de Física, Universidade Federal de São Carlos, São Carlos, São Paulo 13565-905, Brazil — [4]Center for Quantum Sciences and Physikalisches Institut, Eberhard-Karls Universität Tübingen, 72076 Tübingen, Germany

At low optical density, the atom-cavity system is described by the open Dicke model, where collective coupling strength determines the width of normal mode splitting. We apply this to ordered clouds in linear and ring cavities and demonstrate its use in witnessing Wannier-Bloch oscillations. At high optical density, the atomic distribution reshapes the cavity mode, requiring a transfer matrix model. For a periodic atomic lattice, this reveals competing photonic band gaps and normal mode splitting. We discuss the limitations of both models and pathways to more generalized theories.

A 36.41 Thu 17:00 Philo 1. OG

A New-Generation Rydberg Atom Quantum Simulator — •Lukas Klein, Bastien Gély, Mu Qiao, Romain Martin, Thierry Lahaye, and Antoine Browaeys — University Paris-Saclay, Institut Optique Graduate School

We are building a new-generation Rydberg atom array setup for quantum simulations that will replace the existing setup developed at Institut d'Optique over the last decade. With this platform, single atoms are arranged in arbitrary geometries by optical tweezers. Using Rydberg states, it is then possible to implement many-body spin Hamiltonians [1]. Most recent works include the XY spin model [2] and the t-J spin model [3].

I will present the construction of the new-generation setup, that improves several important features of the machine. One major upgrade are the focusing optics, which used to be aspheric lenses on the old setup and are now high NA (0.57) microscope objectives. We are therefore able to generate larger arrays of single Rb-87 atoms.

I will further present some experimental results demonstrating our control over the atoms, such as state preparation and manipulation in ground and Rydberg states. Furthermore, we refined the technique of grey molasses used for cooling and enhanced loading - reaching filling fractions of more than 85%.

References

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[3] M. Qiao *et al.*, *Nature* 644, 889-895 (2025).

A 36.42 Thu 17:00 Philo 1. OG

Towards Bose-Einstein condensation of strongly dipolar mixtures of dysprosium atoms — Lennard Reihs, Marian Duerbeck, Johannes Seifert, Bhalchandra Choudhari, Juan Pablo Marulanda, Nelson Werum, Marco De Pas, Gerard Meijer, and •Giacomo Valtolina — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

Quantum gases of magnetic atoms, such as dysprosium (Dy), can provide access to a wide range of exotic many-body physics. Prominently, this included the recent realization of the long-sought-after supersolid phase. A richer landscape of supersolid phases has been theoretically predicted for mixtures of these magnetic atoms. We report on our efforts to create stable mixtures of Dy. We show a broadly applicable frequency-modulation scheme for simultaneous slowing and trapping of different isotopes of Dy and discuss progress toward producing mixtures of strongly dipolar Bose-Einstein condensates.